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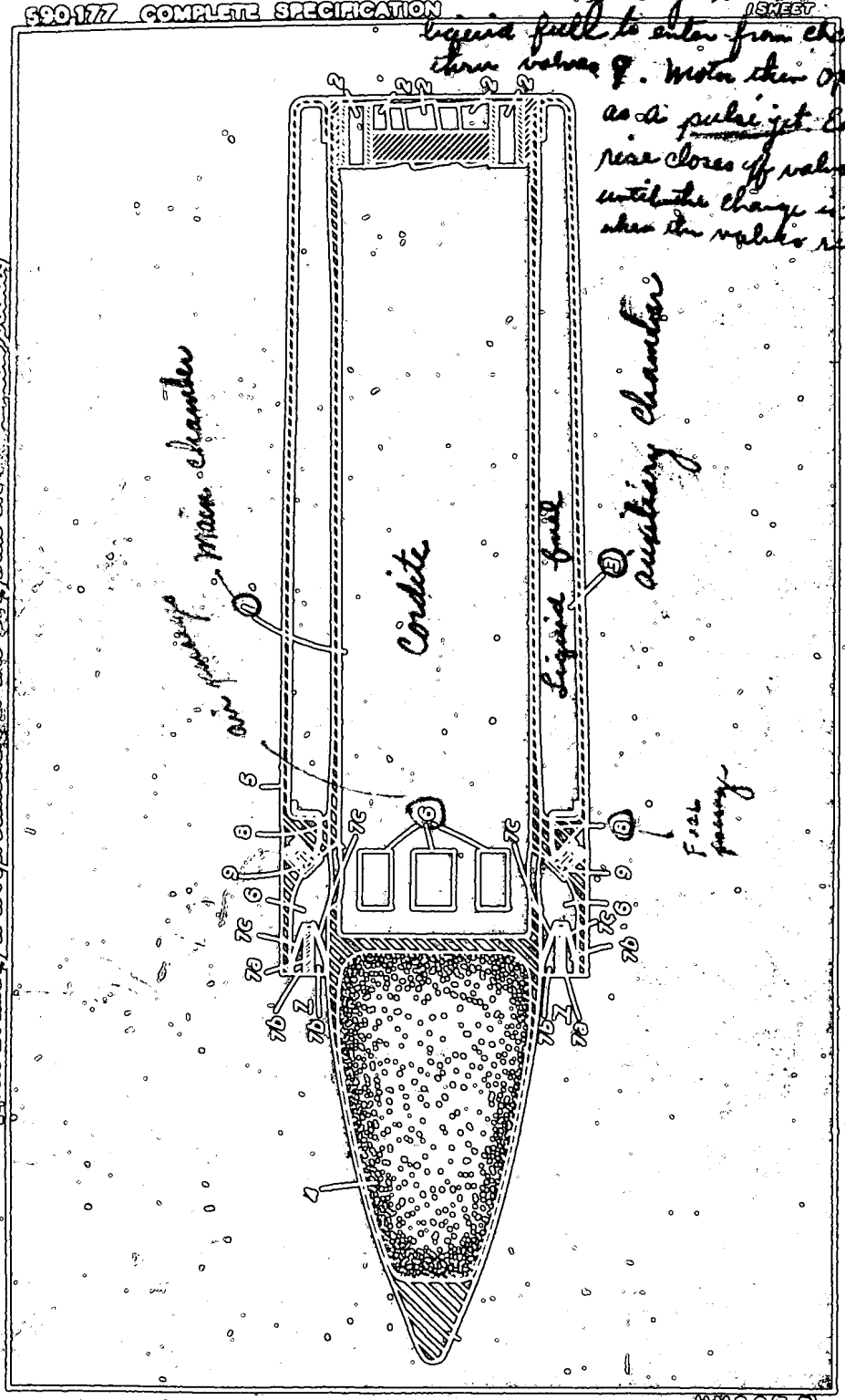
590,177 COMPLETE SPECIFICATION 1 SHEET

This Drawing is a reproduction of the Original on one sheet

Motor operates first as a solid propelled rocket. When cordite charge in chamber 1 is consumed the pressure therein falls allowing air to enter through valves 6 and liquid fuel to enter from chamber 3 thru valves 9. Motor then operates as a pulse jet. Each pressure rise closes off valves 6 and 9 until the charge is burned when the valves re-open.

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# PATENT SPECIFICATION

590,177

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## PROVISIONAL SPECIFICATION

## Improvements in or relating to Projectiles of the Rocket Type

We, HADFAN PRODUCTS LIMITED, a British Company, of Hydra Works, Streatham Road, Staines, in the County of Middlesex, and LEWIS MORLEY, a British Subject, of "Wren House", 13, North Side, Clapham Common, London, S.W.4, do hereby declare the nature of this invention to be as follows:—

This invention relates to projectiles of the rocket type. The object of the invention is the provision of improvements in such projectiles which will enable them to be rapidly accelerated to the required speed and then maintained at said speed for a further considerable period in opposition to the retarding influence of gravity and air resistance.

The invention consists, broadly of a projectile of the rocket type which is launched and initially propelled by the burning of some combustible such as cordite which contains its own oxygen and, subsequently to the exhaustion of this combustible, is propelled by the burning of a combustible mixture of a fuel and air taken from ambient atmosphere.

In accordance with one embodiment of the invention the rocket projectile has a main chamber which contains a cordite propelling charge, and for launching the projectile, this charge is ignited in the usual way so that its products of combustion are discharged from said main chamber through rear orifices and the projectile is propelled forwardly and accelerated to the designed speed.

The projectile also has an auxiliary chamber which contains a body of liquid fuel. This liquid fuel is heated by the burning cordite to boiling temperature, but, so long as pressure is maintained in the main chamber by the burning of the cordite, said fuel is confined in said auxiliary chamber. When however the pressure in the main chamber falls, owing to the cordite charge burning out, communication between the auxiliary chamber and the main chamber is automatically established so that the gaseous oil fuel flows into the main chamber. Also, so long as pressure is maintained in the main chamber, said main chamber is cut off from the outer atmosphere except by way of the aforesaid rear orifices, but when the pressure in the main chamber falls, communication between the outer atmosphere and the front end of the main chamber is established, and air accordingly flows into said main chamber, owing to the velocity of the projectile. This air mixes with the gaseous oil fuel and a combustible mixture is formed, and this is ignited owing to the heat of the main chamber, and the products of combustion discharge through the rear orifices as before. This again generates pressure in the main chamber, which again cuts said main chamber off both from the liquid fuel and the outer atmosphere. When the quantity of combustible mixture, which was admitted before the cut-off point, is burnt, the pressure in the main chamber again falls, and communication is again established both with the oil fuel and with the outer atmosphere. Thus another combustible charge is admitted which again becomes ignited whereupon the fuel and air are again cut off, and so on.

Thus, the burning of the cordite charge first launches the projectile and accelerates it to the designed speed, after which the burning of successive charges of the oil fuel maintains a pulsating propelling force which keeps the projectile up to speed until the oil fuel is also exhausted.

In construction, the projectile is generally in the form of a cylinder with its nose coming to a point. The main chamber is of cylindrical form and the nose portion extends smoothly from the front end of said main chamber. Surrounding said main chamber is an annular cylindrical structure which extends from the base of the nose portion to the rear of the main chamber. This structure stands out so that its forward face is uninterruptedly exposed to the atmosphere. Throughout the major portion of its length from the rear end to a point near the front end this structure is hollowed thereby forming an annular chamber, and this annular chamber is the auxiliary chamber containing the liquid fuel.

[Price 1/-]

The means of communication from the outer atmosphere to the main chamber are constituted by a number of air conduits which extend from the front face of the cylindrical annular structure, through the solid portion of said structure beyond the forward end of the auxiliary chamber, and into the main chamber near its forward end. These air conduits, which may be of rectangular section, are spaced at equal intervals around the annular structure and extend first rearwardly and then bend inwardly to enter the main chamber. In the forward ends of these air conduits are arranged grid venturis through which the air is forced at pressure owing to the high velocity of the projectile, and these grid venturis are controlled by flap valves which seat on the grids and keep the venturis closed so long as there is sufficient pressure in the main chamber.

The means of communication from the auxiliary chamber to the main chamber are constituted by relatively narrow fuel passages extending from the front end of said auxiliary chamber and terminating in jets in the respective air conduits. These fuel passages are controlled by means of reduction valves, and thus fuel cannot pass from the auxiliary chamber to the main chamber so long as there is sufficient pressure in the main chamber.

The rear orifices, through which the products of combustion are discharged from the main chamber, take the form of the usual venturis which are helically orientated so that the projectile is stabilized by rotation. The auxiliary chamber may extend rearwardly beyond the rear end of the main chamber, so as to surround and protect these venturis.

The nose portion of the projectile may contain a high explosive charge.

Dated this 17th day of July, 1944.
A. A. THORNTON,
Chartered Patent Agent,
7, Essex Street, Strand, London, W.C.2.
For the Applicants.

## COMPLETE SPECIFICATION

# Improvements in or relating to Projectiles of the Rocket Type

We, HYDRAN PRODUCTS LIMITED, a British Company, of Hydra Works, Gresham Road, Staines, in the County of Middlesex, and LEWIS MOTLEY, a British Subject, of "Wren House", 13, North Side, Clapham Common, London, S.W.4, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to projectiles of the rocket type. The object of the invention is the provision of improvements in such projectiles which will enable them to be rapidly accelerated to the required speed and then maintained at said speed for a further considerable period in opposition to the retarding influence of gravity and air resistance.

The invention consists broadly of a projectile of the rocket type which carries both a combustible, such as cordite, which contains its own oxygen, and also a fuel which requires additional oxygen for its combustion, the launching and initial propulsion of said projectile being effected by the combustion of said combustible, and the subsequent propulsion being effected by the burning of a combustible mixture of said fuel and air taken from the ambient atmosphere.

In order that the invention may be the more clearly understood a projectile in accordance therewith will now be described, reference being made to the accompanying sectional elevational drawing.

Referring to this drawing the rocket projectile has a main chamber 1 which contains a cordite propelling charge, and, for launching the projectile, this charge is ignited in the usual way, so that its products of combustion are discharged from said main chamber through rear orifices 2 and the projectile is propelled forwardly and accelerated to the designed speed.

The projectile also has an auxiliary chamber 3 which contains a body of liquid fuel. This liquid fuel is heated, by the burning cordite in the main chamber 1, to boiling temperature, but, so long as pressure is maintained in said main chamber by the burning of the cordite, said fuel is confined in said auxiliary chamber. When however the pressure in the main chamber 1 falls, owing to the cordite charge burning out, communication between the auxiliary chamber 3 and the main chamber is automatically established so that the gaseous oil fuel flows into the main chamber. Also, so long as pressure is maintained in the main chamber 1, said main chamber is cut off from the outer atmosphere except by way of the aforesaid rear orifices 2, but when the pressure in the main chamber falls, owing to the cordite burning out, communication between the outer atmosphere and the front end of the main chamber is established, and air

flows into said main chamber owing to the velocity of the projectile. The air mixes with the gaseous oil and a combustible mixture is formed in the main chamber 1, and this is ignited owing to the heat of said main chamber, and the products of combustion escape through the rear orifices 2 as before. This again generates pressure in the main chamber 1, which again cuts said main chamber off both from the liquid fuel in the auxiliary chamber 3 and from the outer atmosphere. When the quantity of combustible mixture, which was admitted to said main chamber 1 before the cut-off point, is burnt, the pressure in said main chamber again falls, and communication is again established both with the oil fuel in the auxiliary chamber 3 and with the outer atmosphere. Thus another combustible charge is admitted which again becomes ignited whereupon the fuel and air are again cut off, and so on.

Thus, the burning of the cordite charge first launches the projectile and accelerates it to the designed speed, after which the burning of successive charges of the oil fuel maintains a pulsating propelling force which keeps the projectile up to speed until the oil fuel is also exhausted.

In construction, the projectile is, as shown, generally in the form of a cylinder with its nose 4 coming to a point. The main chamber 1 is of cylindrical form and the nose portion 4 extends smoothly from the front end of said main chamber. Surrounding said main chamber is an annular cylindrical structure 5 which extends from the base of the nose portion to the rear of the main chamber. This structure stands out so that its forward face is uninterruptedly exposed to the atmosphere as shown. Throughout the major portion of its length from the rear end to a point near the front end this structure 5 is hollowed thereby forming an annular chamber, and this annular chamber is the auxiliary chamber 3 containing the liquid fuel.

The means of communication from the outer atmosphere to the main chamber are constituted by a number of air conduits 6 which extend from the front face of the cylindrical annular structure 5, through the solid portion of said structure beyond the forward end of the auxiliary chamber 3, and into the main chamber 1 near its forward end. These air conduits 6, which may be of rectangular section, are spaced at equal intervals around the annular structure and extend first rearwardly and then bend inwardly to enter the main chamber. In the forward end of these air conduits 6 are arranged non-return valves 7 which enable atmospheric air to flow through said conduits from front to rear when the atmospheric pressure at the front end of said conduits is greater than the gas pressure in the chamber 1 at the rear end of said conduits, but which prevent flow of gas from rear to front when the gas pressure in the chamber 1 at the rear is greater than the atmospheric pressure at the front. These non-return valves 7 may consist each of a conical body member 7*a* arranged in the front end of the conduit 6 with the base end forward so as to fill said conduit, said body member having cut in it a number of slots 7*b* in radial planes and extending longitudinally through said body member and said slots where they break out at the conical surface of said body member being yieldably closed by means of flap valve members 7*c* anchored near the base end of the body member.

The means of communication from the auxiliary chamber 3 to the main chamber 1 are constituted by relatively narrow fuel passages 8 extending from the front end of said auxiliary chamber and terminating in jets adapted to project the fuel into the respective air conduits 6. These fuel passages 8 are controlled by means of reduction valves 9, in such a way that fuel cannot pass from the auxiliary chamber 3 to the main chamber 1 so long as there is sufficient pressure in the main chamber.

The rear orifices 2, through which the products of combustion are discharged from the main chamber 1, take the form of the usual venturis which are helically orientated so that the projectile is stabilised by rotation. The auxiliary chamber 3 may extend rearwardly beyond the rear end of the main chamber 1, as shown, so as to surround and protect these venturis.

The nose portion 4 of the projectile may contain a high explosive charge.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A projectile of the rocket type which carries both a combustible, such as cordite, which contains its own oxygen, and also a fuel which requires additional oxygen for its combustion, the launching and initial propulsion of said projectile being effected by the combustion of said combustible and the subsequent propulsion being effected by the burning of a combustible mixture of said fuel and air taken from the ambient

atmosphere.

2. A projectile according to claim 1, wherein said projectile has a main chamber which contains said combustible and which has associated rear orifices through which the products of combustion are adapted to be discharged for propelling the projectile, and said projectile also has an auxiliary chamber which contains a body of said fuel adapted to be heated by the burning combustible in the main chamber, and means are provided whereby first said fuel is cut off from said main chamber and the ambient atmosphere is excluded from said main chamber, and, after the combustible is exhausted or substantially so, fuel is admitted from said auxiliary chamber to said main chamber, and air is admitted from the ambient atmosphere to said main chamber.

3. A projectile according to claim 2, wherein the admission of fuel and ambient air to the main chamber takes place in response to the fall of pressure in the main chamber consequent upon the substantial exhaustion of said combustible.

4. A projectile according to claim 3, wherein, in response to the subsequent rise in pressure in the main chamber consequent upon the combustion of fuel and air therein, the fuel in the auxiliary chamber and the ambient air are again cut off from said main chamber, until the charge of fuel and air is substantially exhausted, whereupon, in response to the consequent fall of pressure in the main chamber, fuel and air will be again admitted and so on.

5. A projectile according to claim 3 or 4, wherein the admission of fuel and ambient air to the main chamber take place under control by pressure controlled valve means.

6. A projectile according to claim 5, wherein the admission of ambient air to the main chamber takes place by virtue of air pressure set up by the velocity of the projectile, and the pressure-controlled valve means to control such admission of ambient air consist of non-return valve means which admit the air only when the said air pressure is in excess of the pressure in the main chamber.

7. A projectile according to claim 5 or 6, wherein the admission of fuel to the main chamber takes place by virtue of the pressure in the auxiliary chamber generated by the heat transmitted thereto from the main chamber, and the pressure-controlled valve means to control such admission of fuel consist of reducing valve means which admit the fuel only when the pressure in the auxiliary chamber is much in excess of that in the main chamber.

8. A projectile according to claim 6 or any of the claims appendant to claim 6 wherein the general outside shape of the projectile is that of a cylinder with a nose extending from the forward end thereof, the rear end of the nose being of less diameter than the cylinder whereby a forwardly facing annular surface is formed against which the air pressure is high, and the air passages from the atmosphere to the main chamber open at said annular surface.

9. A projectile according to any of claims 2 to 8, wherein the main chamber is an inner cylindrical chamber and the auxiliary chamber is an outer annular chamber surrounding said main chamber.

10. A projectile according to any of the preceding claims wherein a high explosive charge is located in the forward end of said projectile.

11. A projectile of the rocket type substantially as herein described with reference to the accompanying drawings.

Dated this 17th day of July, 1945.

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